STAGE 2 GEO-ENVIRONMENTAL REPORT

AT

DOWKER STREET

MILSNBRIDGE

ON BEHALF OF

WESTSHIELD LIMITED

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1.0 EXECUTIVE SUMMARY

The pertinent conclusions of the report are tabulated below. However, the information below is not exhaustive, and it is recommended the report is read in its entirety.

Proposed Development	Residential dwellings with private gardens.
Existing Site Description	Demolition rubble and/or concrete slabs present at ground level associated with historical factory. Site slopes down from north to south by up to 4.5m. Culvert below western flank. North under dense vegetation cover (large bushes/small trees).
Site History	By 1896, the site was occupied by "Britannia Mills" and remained in industrial use through the 20th century. Most recently used for precision engineering (valves). Buildings demolished in the 2010s.
Geology	Alluvium, overlying Millstone Grit Group strata (sandstone).
Coal Mining	Site can be considered stable.
Hazardous Gases	No radon protection measures required. No landfills within 250m. No gas protection measures required.
Ground Conditions	Made ground, locally greater than 3.35m thick, overlying alluvium. The alluvium is typically granular (sand and gravel with variable content of cobbles and boulders); locally an upper layer of clay is present. Sandstone bedrock between around 2.70m and 3.70m.
Contamination	Elevated arsenic, copper, lead, PAH, and also chrysotile asbestos.
Remediation Strategy	Provision of a cover blanket of 0.6m thickness in proposed gardens/landscaping with 100mm thick hard break layer provided at the base. Also, retention below hard areas.
Foundations	Where made ground is >2.5m and also adjacent to culvert, pier/pad and beam foundations likely to be favoured. Piled foundations could also be considered. In the centre and north, standard strip or trench fill foundations could be used.

Excavations	Likely to be stable within natural strata, but instability can be expected within made ground. Significant concrete substructures should be anticipated. Significant groundwater entry unlikely provided periods after high preceding rainfall are avoided.
Concrete	FND3 designation for unreinforced buried concrete. For any reinforced concrete, other design-specific mixes will apply.
Soakaways	Not considered to be suitable for use on the site.
Road Pavement	Due to the depth of made ground and the presence of the culvert, an engineered solution for road pavement, is likely to be required.

2.0 TERMS OF REFERENCE

2.1 Westshield Limited is considering developing the site at Dowker Street, Milnsbridge, near Huddersfield, with residential properties. It was considered appropriate to provide information to aid viability assessment and design of any subsequent development. In June/July 2006, Faber Maunsell issued a Stage 1 Desk Study Report, which included a site walkover inspection and preliminary risk assessment. This report involved an assessment of the geological and coal mining aspects, Ordnance Survey archive maps, radon gas, indicative flood risk, hydrogeology, landfill, and other environmental issues, primarily by assessment of a Landmark Envirocheck Report. In addition to comments and conclusions on environmental and geotechnical issues, the report also provided recommendations for intrusive investigation and assessment.

2.2 In May 2015, ARP Geotechnical Ltd was appointed by a different client (Invicta Developments Ltd) to undertake the recommended further works, with the intrusive investigation comprising trial pits to assess the ground conditions. The resulting Stage 2 Geo-environmental Report, was issued in July 2015 under reference INV/01r1a. Invicta Developments Ltd gave consent for the information contained in the report to be utilised to provide an updated report suitable for support of a new planning application by Westshield Limited.

2.3 In May 2023, ARP Geotechnical Ltd, was appointed by Westshield Limited to undertake a supplementary investigation in order to confirm there have been no significant changes to the ground conditions since 2015, and provide an updated composite Stage 2 Geo-environmental Report.

2.4 The investigation was implemented generally in accordance with BS 5930:2015 +A1:2020 "Code of practice for site investigations", NHBC Standard Chapter 4.1 "Land quality - managing ground conditions", Environment Agency LCRM "Land Contamination Risk Management" and BS10175: 2011 + A2: 2017 "Investigation of potentially contaminated sites - Code of practice". This report is limited to the data obtained as part of this investigation. It should be noted that there is a possibility of variation in ground conditions between test locations and interpretation

of strata is given for guidance only. No liability is accepted for changes to site conditions, including groundwater levels, after the preparation of this report.

2.5 The findings or contents of the Stage 1 Desk Study Report are not reproduced here in full, and it is recommended that this report is read in conjunction with the Stage 1 Report.

2.6 The general observation and assessment of the ground surface, and the identification/classification of vegetation is made in general terms only. It would be prudent for a specialist to undertake a more detailed survey, including for any invasive/harmful weeds.

2.7 The assessment of any topsoil is carried out in terms of potential chemical effects on human health only, and no account is taken of aesthetic or horticultural properties. Such considerations should be referred to a horticulturist or landscape architect.

2.8 The report has been prepared for the use and reliance of the Client only. The report shall not be relied upon or transferred to any other parties without the written agreement of ARP Geotechnical Ltd. For the avoidance of any doubt, where ARP Geotechnical Ltd enters into a letter of reliance for the benefit of a third party, that third party will be permitted to rely on the report. No responsibility will be accepted where this report is used, either in its entirety or in part, by any other party without ARP Geotechnical Ltd.'s consent.

2.9 Attention is drawn to the requirements of the Construction Design and Management Regulations 2015, and in particular the duties and obligation of the Client.

2.10 The report refers to and includes a copy of an indicative proposed layout. This is only for the purposes of generating a conceptual site model for the contamination risk assessment. Unless the proposed layout changes significantly, such that the conceptual model and risk assessment is affected, there is no requirement to re-issue this report when the layout is revised.

3.0 THE SITE

Site Location

3.1 The site, which is centred on Ordnance Survey Grid Reference 411620, 416070, is located off Dowker Street, in Milnsbridge, West Yorkshire.

3.2 An aerial photograph (image taken in 2022) showing the site location, and a proposed site layout, are presented in Appendix A. An aerial photograph taken in 2011 is also presented in Appendix A, showing the original mill buildings.

Site Description

3.3 The site, which is roughly rectangular in shape, with an overall area of approximately 0.63 hectares, was previously occupied by a valve manufacturing works (precision engineering). A detailed description of the site prior to demolition is included in the Stage 1 Desk Study Report prepared by Faber Maunsell. The Stage 1 Report indicates that, prior to closure of the works, a warehouse was located in the northern half of the site and machine shops were present in the south.

3.4 At the time of the ARP intrusive investigation in 2015, the factory buildings had been demolished and the resulting demolition rubble used to raise levels across parts of the site. Elsewhere, concrete slabs were present at ground level. A derelict house was located in the northeast of the site.

3.5 At the time of the supplementary investigation in 2023 the northern end of the site was under dense vegetation cover (large bushes and small trees), with only a small clearing in the northeastern corner. Photographs of the site are presented in Appendix B, taken on the 15th May 2023. Much of the northern end of the site was impenetrable due to the density of the vegetation. A blanket of whole bricks was visible at the surface within the area of dense vegetation. A small concrete slab was present within the clearing in the northeast, likely to be

associated with the house observed on site in 2015. The southern end of the site comprised surfacing of either concrete slabs, or demolition rubble with patches of vegetation. Evidence of fly tipping, including nappies, mattresses and general rubbish, was present across much of the site. A narrow stockpile, approximately 1.5m high, of whole bricks was present towards the north centre of the site, marking the boundary with the densely vegetated area of the site further north.

3.6 A culvert, aligned north - south, crosses the western flank of the site, and discharges to the River Colne, approximately 30m to the south. Ground levels across the site slope gradually downwards from north to south, with a total elevation difference of approximately 4.5m. The southeastern corner of the site is approximately 1m lower than the concrete slab to the south.

3.7 Adjacent land use is residential to the north and south, retail/commercial to the west and mixed light industrial and residential to the east.

Site History

3.8 The review of Ordnance Survey archive maps by Faber Maunsell indicates that by 1896, the site was occupied by "Britannia Mills" and some residential buildings. The Stage 1 report states that "the Longwood Brook runs in a southerly direction in a culvert 35m to the west of the site". A railway, aligned east – west, is located approximately 90m to the north of the site, but at a much higher level. At that time, the site was located in an industrialised setting, with several mills, a dye works, and a gas works located within 200m.

3.9 The site remained in industrial use through the 20th century. By 1961, the site was annotated as a "Works", with a telephone exchange indicated in the southeast. Later, the site was used by Taylor Valves Ltd.

3.10 According to internet sources, the factory burned down in 2011.

4.0 ENVIRONMENTAL SETTING

4.1 The environmental setting for the site was established by the Stage 1 Desk Study Report undertaken by Faber Maunsell and dated July 2006. In order to check for any changes that may have occurred to environmental aspects since 2006, an updated Envirocheck Report (excluding OS Maps) has been obtained by ARP, and this is presented in Appendix C. The findings of the Desk Study Report and the new Envirocheck Report, are summarised below (updated and amended where deemed appropriate).

Geology

4.2 The geological maps show the site to be underlain by alluvium, which is in turn underlain by solid strata of the Millstone Grit Group. These are shown to comprise Huddersfield White Rock (sandstone) on most of the site, and the Midgley Grit on the northeast of the site. There are no faults shown to affect the site.

Coal Mining

4.3 The Coal Mining Report (contained within the Faber Maunsell Desk Study) indicates the site is not affected by past, present or future (planned) coal mining. In addition, there are no mine entries shown on, or within 20m of the boundary of, the site. The site is considered stable with regard to coal mining.

Hydrogeology

4.4 The Landmark Envirocheck Report indicates the Bedrock Aquifer Designation to be "Secondary A". The overlying superficial alluvium is also designated a "Secondary A" Aquifer.

4.5 There is one active groundwater abstraction within 1km of the site, at 158m to the east. The abstraction is for general use in the textile and leather industry.

4.6 The site is not within a groundwater Source Protection Zone.

Hydrology

4.7 The nearest watercourse downslope is the River Colne, located approximately 30m to the south, and flowing from west to east. Any surface water run-off, which is not intercepted by drainage, is likely to eventually reach this river. The majority of the site is shown to be within Flood Zone 2 (Extreme Flooding), with the exception of the northeastern corner.

4.8 There are three surface water abstractions within 1km down gradient of the site, at approximately between 59m and 642m to the east. All three abstractions are for general use within the textile and leather industry.

Other Relevant Environmental Data

4.9 There are no closed or currently licensed landfills within 250m of the site.

4.10 No radon protective measures are stated to be necessary for new dwellings or extensions on the site, and the site is within a "lower probability radon area".

4.11 BGS data indicates the general area has the "limited potential for groundwater flooding of property situated below ground level".

4.12 As part of the 2006 Desk Study Report, a request for information was made to West Yorkshire Fire and Rescue. Their response indicates that they could find no details of any underground fuel (petroleum) storage tanks on the site.

Potential Contamination Sources

4.13 The following potential sources of contamination were identified in the Stage 1 Desk Study Report

4.13.1 Possible made ground – metals, inorganics, TPH, PAH, phenol, asbestos.

4.13.2 Additional possible contamination due to the previous industrial uses on the site and from adjacent industrial land.

5.0 SITE INVESTIGATIONS

ARP Geotechnical Site Investigation 2016

5.1 A site investigation was undertaken by ARP in May 2015 comprising 12 machine excavated trial pits (TP1 to TP12) to between 1.6m and 3.8m depth. Due to the presence of a culvert below the western flank of the site, trial pits were not excavated in this location.

5.2 Eleven samples of made ground were sent to an accredited laboratory for a general suite of testing. Elevated determinands were tested further for leachability to determine the potential mobility of the contaminants.

5.3 Analysis for Atterberg Limits and moisture content was undertaken by the UKAS accredited Professional Soils Laboratory (PSL) in Doncaster. Geochemical testing comprising pH and water-soluble sulphate was undertaken by DETS.

ARP Supplementary Investigation 2023

5.4 A supplementary site investigation was undertaken by ARP Geotechnical Ltd on 15th May 2023. The purpose of the investigation was to supplement the existing site investigation with further investigation, in order to produce an up to date assessment of the site in accordance with BS10175: 2011 + A2: 2017 "Investigation of potentially contaminated sites - Code of practice", and to provide geotechnical information to aid design of the development.

5.5 Windowless sample boreholes were implemented at selected locations to achieve an approximate 25m grid across the site (in combination with the original site investigation locations), to satisfy the requirements of the British Standard. Four boreholes (WS2 to WS5) were formed, to depths of between 2.2m and 3.1m. At the time of the 2023 investigation, vegetation in the northern end of the site was too dense to allow access with a window sample rig. Therefore, one of the proposed windowless sample locations was replaced with a hand pit WS1(HP). The hand pit and boreholes were organised, supervised, and logged by an Engineer from ARP Geotechnical Ltd. Justifications for the 2023 ARP investigation locations are given below.

LOCATION	REASON
WS1(HP)	Obtain a sample in northeastern end of the site.
WS2 and WS3	General grid within the centre of the site.
WS4 and WS5	General grid and to confirm thickness of made ground beneath existing floor slab.

5.6 The hand pit and borehole location plan and logs are included in Appendix E.

5.7 Chemical analysis of five soil samples, for metals, inorganics, speciated PAH, TPH, phenols, and asbestos, was undertaken by the UKAS accredited Eurofins Chemtest Laboratory in Newmarket. The test certificates are included in Appendix F.

Appendices

5.8 The engineers logs and location plan, from the investigations carried out by ARP in 2015 and 2023, are included in Appendix E.

5.9 The laboratory test certificates from the investigations carried out by ARP in 2015 and 2023, are included in Appendix F.

6.0 SUMMARY OF GROUND CONDITIONS

ARP 2015 Site Investigation

6.1 During the 2015 investigation, concrete slabs were encountered in the majority of the pits. TP1 and TP2 were excavated through a reinforced concrete slab, which was suspended on steel beams. Below the suspended slab, made ground was proven to depths of greater than 3.35m (TP1) and 2.80m (TP2), suggesting the presence of a backfilled basement. Concrete at the surface was also present in TP3 (in the west) and TP5 (in the northeast), while buried concrete slabs were also encountered in TP4 at 0.15m, TP8 at 1.60m, TP10 at 0.80m and TP11 at 0.55m. The concrete slabs ranged in thickness from 150mm to 400mm thick.

6.2 The made ground generally comprised either demolition rubble or ash and clinker made ground. The more recent demolition rubble consisted of cobbles and boulders of brick, masonry and concrete at or near the surface, and older demolition rubble typically consisted of sandy, gravelly cobbles of brick and sandstone, with the smaller material made up of ash, clinker, brick and sandstone. The ash and clinker made ground comprised sand and gravel of ash, clinker, brick and tile fragments with occasional cobble sized fragments of sandstone.

6.3 Reworked alluvium was encountered in TP11, which was excavated close to the location of the culvert in the northwest. Thin beds of cohesive made ground were also proven at the base of the granular made ground in TP9 and TP10, both located in the east.

6.4 The made ground was deepest in the south (TP1 and TP2), extending to 2.80m and below 3.35m, and also in TP11 in the northwest (2.9m). The made ground was shallowest in the northeast (TP5), where a concrete slab was found to be underlain directly by cohesive alluvium.

6.5 The made ground was generally found to be underlain by granular alluvium, with cohesive alluvium present in the northeast and south. The cohesive alluvium was in turn underlain by the granular deposits. The granular alluvium comprised very soft to firm, and occasionally stiffer, sandy clay. The granular deposits consisted of sand, gravel and cobbles of sandstone, locally within a clay matrix.

6.6 Sandstone bedrock was proven at 3.70m in the southeast (TP9), and between 2.70m and 3.20m in the central site area (TP3, TP10 and TP12). It was not encountered in the north. In TP10, the upper bedrock was weathered to very stiff, slightly sandy clay. Possible sandstone bedrock was also encountered in TP2 at 3.30m and TP4 at 2.40m, and at 2.80m in TP5 and TP6.

6.7 The excavations were generally unstable in the made ground and remained stable in the natural soils for the short period of exposure. The pits were backfilled with the arisings on completion. Groundwater seepage was only observed in TP11 at 3.00m. TP11 was positioned adjacent to the culvert in the northwest.

Supplementary Investigation 2023

6.8 The 2023 investigation encountered reinforced concrete at the surface across the majority of the site, between 0.15m and 0.3m thick. In WS01 (HP) which was a hand pit, gravelly sand with fragments of brick, concrete, and sandstone, was encountered to at least 0.25m depth. The surface covering was underlain by generally granular, occasionally cohesive, made ground to depths of between 0.45m and 2.0m. The made ground included gravel and cobbles of brick, concrete, and sandstone, with occasional ash.

6.9 The made ground was underlain by alluvium comprising soft and firm clay, occasionally stiff, gravelly sand, and clayey/sandy cobbles, to depths of between 1.4m and 3.0m. In WS2 and WS3, the alluvium was underlain by granular residual soils (derived from in situ weathering of bedrock) to depths of between 2.0m and 3.0m.

6.10 The windowless samples terminated at between 2.21m and 3.3m depth, by SPT refusal (N value >50). This was interpreted to be bedrock.

6.11 No groundwater ingress was encountered during the 2023 investigation.

7.0 CONTAMINATION ANALYSIS

Screening Values - Soils

7.1 There is presently conflicting opinion with regard to the appropriate generic assessment criteria, or screening values, for soils which should be used in contamination assessment for proposed development. In March 2014, DEFRA published Category 4 Screening Levels (C4SLs) for six contaminants: arsenic, benzene, benzo(a)pyrene, cadmium, chromium VI and lead. The values are based on the toxicological benchmark of a "low level of toxicological concern" (LLTC) rather than the previous regulatory approach of "minimal or tolerable level of risk". As the C4SLs are less protective of health than the previous approach, the Chartered Institute of Environmental Health (CIEH) has advocated an alternative approach based on minimal risk, but with some adjustment of exposure parameters to more realistic scenarios than those previously used. To this end, the CIEH has collaborated with Land Quality Management to publish "Suitable 4 Use Levels" (S4ULs) "The LQM/CIEH S4ULs for Human Health Risk Assessment", November 2014 (LQM/CIEH). However, DEFRA has reiterated its intention that the C4SLs should be used in generic risk assessment for proposed development, and there is indication that other parties will collaborate, in the near future, to extend the range of C4SL determinands beyond the six published so far.

7.2 In the absence of a final resolution to the debate, soil contamination test results in this report have been compared first against the more conservative S4UL, and where a C4SL exists for the same determinand, consideration given to the use of the C4SL for any exceedances of the S4UL, within the site-specific context (including the use of benzo(a)pyrene as a surrogate marker for genotoxic PAH compounds, where appropriate). Where no S4UL exists for a determinand, for example lead, the C4SL has been used. The LQM/CIEH screening values have been calculated for soil organic matter contents of 1% and 2.5%, as well as 6%, and the appropriate screening value is used for the organic matter content of the soil. All the C4SL values published are for a soil organic matter content of 6%.

7.3 A table showing the screening values utilised is included in Appendix F. The lowest organic matter content has been assumed, for determinands where the screening value is organic matter-dependent.

Screening Values - Leachability

7.4 In order of preference, the Environmental Quality Standards (EQS) annual averages for freshwater have been used as generic screening values for these results. Where no EQS is available, the stringent UK Drinking Water Standards (DWS) have been used, and other sources in the absence of EQS and DWS, as indicated on the groundwater screening values table in Appendix F.

Soils Analysis

7.5 A combined total of 16 soil samples was issued to DETS (2015 investigation) and Eurofins Chemtest (2023 investigation) for the suite of testing (As, Cd, Cr (VI), Cr(III), Cu, Hg, Ni, Pb, Se, Zn, Total Sulphate, Water Soluble Sulphate, pH, Phenol-monohydric, Speciated PAH, Total TPH, Asbestos, and Organic Matter). The testing comprised:

- Two Samples of possible reworked natural from TP11 and WS2.
- Fourteen samples of Made Ground from TP1, TP2, TP3, TP4, TP6, TP7, TP8, TP9, TP10, TP12, WS1(HP), WS3, WS4 and WS5.

7.6 For general made ground, any determinands with exceedances of screening values were subjected to statistical analysis to determine the 95% Upper Confidence Level (UCL). During the reporting of the 2015 investigation, the made ground identified on site was split into two different types - demolition rubble, and ash and clinker made ground. However, given the occasional presence of ash and clinker within material classed as demolition rubble and based on the made ground identified during the 2023 investigation, it is considered justifiable to combine the two types of made ground for the purposes of this assessment. Statistical analysis was not possible of the two samples of possible reworked natural material, TP11 and WS2.

Made Ground

7.7 A results summary table for determinands within the made ground found to be above screening values is given below.

Location	Depth (m)	B(a)P	Napthalene	Arsenic	Copper	Lead	Asbestos
TP1	**0.5-1.0**	1.9	0.3	11	350	130	NAD
TP2	**0.5**	0.6	0.1	12	36	72	NAD
TP3	**0.6-1.0**	0.1	0.1	91	160	90	NAD
TP4	**0.5-1.0**	15	13	21	110	320	NAD
TP6	**0.3-0.5**	0.3	1.4	16	190	140	Chrysotile
TP7	**0.3-0.5**	0.4	0.1	15	410	230	NAD
TP8	**0.5-1.0**	0.1	0.2	13	370	180	Chrysotile
TP9	**0.3-0.6**	2.3	0.1	12	74	110	NAD
TP10	**0.3-0.5**	0.1	0.4	5.4	74	100	Chrysotile
TP12	**0.6-1.0**	15	6.2	88	8200	990	Chrysotile
WS1(HP)	**0.2-0.25**	0.1	0.1	6.3	37	150	NAD
WS3	**0.5-0.6**	4.5	0.52	16	45	340	NAD
WS4	**0.5-0.7**	7.6	0.77	16	54	130	NAD
WS5	**0.5-0.6**	7.3	0.85	16	57	140	NAD
Screening Values		**5**	**5.6**	**37**	**2400**	**200**	**NAD**
95% UCL		**6.5**	**3.4**	**37**	**215***	**203***	**-**
Exceedance							
Acceptable							
*Following removal of outlier							
Values are in mg/kg unless indicated otherwise							

7.8 It can be seen from the table that the 95% UCL concentrations of naphthalene and arsenic are below the screening value, with no outliers. However, concentrations of benzo(a)pyrene and lead, at 95% UCLs of 6.5mg/kg and 203mg/kg respectively, will need to be considered further in the risk assessment, as the 95% UCL concentrations are above the screening value.

7.9 As EPH concentrations above 500mg/kg were recorded in samples of made ground obtained from TP4, TP6, TP10 and TP12, speciated analysis with aliphatic: aromatic split was undertaken during the 2015 investigation and the results compared with the appropriate screening values. The further assessment indicates that the recorded TPH concentrations are all well below the screening values, and therefore do not pose any risk to human health.

7.10 It can also be seen that microscopic fibres of asbestos as chrysotile were identified within the made ground at four locations (TP6, TP8, TP10 and TP12) excavated during the 2015 investigation. This will need to be considered further.

Water/Leachability Analysis

7.11 During the 2015 investigation, leachability testing was carried out on the samples from made ground showing elevated benzo(a)pyrene. The laboratory test certificates are presented in Appendix F. The analysis shows the determinands have negligible leachability. Therefore, if the contamination was to be retained on site below a cover material, the contamination would be effectively immobile with respect to water/groundwater transport.

Updated Risk Assessment and Conceptual Model

7.12 The categorisations of risk adopted in this report are adapted from CIRIA Report C552 (Contaminated Land Risk Assessment: A Guide to Good Practice, 2001). This approach assesses the potential severity of any pollution event and the probability of the event occurring, to arrive at a risk category, for the various potential source - pathway - receptor linkages. The relevant tables used, with the definitions, are presented in Appendix D.

7.13 The updated source – pathway – receptor matrix is presented below, taking into account the findings of the investigation. Any pathways in italics are deemed not to be viable and the reason given.

Viable Source - Pathway - Receptor Matrix (Finished Development)

Contamination Sources	Pathways	Receptors	Severity of Consequence	Probability of Event	Risk
Elevated concentrations of lead and benzo (a)pyrene within the made ground.	• Inhalation, ingestion and dermal contact with soil and dust	**Humans: -** • Future occupants • Maintenance workers • Adjacent residents and general public	**Medium**	**Low Likelihood**	**Moderate/ Low**
	• Fruit and vegetable intake, with soil	**Humans (as above)**	**Medium**	**Low Likelihood**	**Moderate/ Low**
	• *Vapour inhalation outdoor (negligible volatility)*	**Humans (as above)**	**Negligible**		
	• *Vapour inhalation indoor (negligible volatility)*	**Humans (as above)**	**Negligible**		
	• Migration in surface water	• Surface water (nearest downslope is 20m to south. No sensitive abstractions within 1km)	**Mild**	**Unlikely**	**Very Low**
	• Migration in groundwater (negligible leachability)	• Groundwater (Secondary A Aquifer, no sensitive abstractions within 1km)	**Negligible**		
	• Root uptake	**Vegetation: -** • Landscape areas • Private gardens	**Medium**	**Low Likelihood**	**Moderate/ Low**
	• Migration	**Services/Utilities: -** • Potable water supply	**Medium**	**Low Likelihood**	**Moderate/ Low**
Asbestos fibres within the made ground.	• Inhalation	• Future occupants • Maintenance workers • Adjacent residents and general public	**Severe**	**Low Likelihood**	**Moderate**

7.14 It can be seen from the above matrix that several pathways to receptors are operative, and this may affect users of the finished development, with a moderate/low risk applicable. Some form of remedial action is, therefore, considered necessary to allow residential development without excess risk.

Risk Based Assessment of Remedial Options

Made Ground - Ingestion, Dust Inhalation, Dermal Contact, Root Uptake, and Fruit and Vegetable Intake, With Soil

7.15 This pathway is automatically blocked where buildings or hardstanding are present above the material. However, in garden areas, provision of a cover blanket of a minimum 0.6m thickness will be required, to reduce the risk to future users of the site to acceptable levels from these pathways. This assumes a worst-case double dig scenario (i.e., 2 x spade depths). (However, to prevent inadvertent future exposure due to other forms of excavation such as tree planting or construction of ponds, a hard break layer or robust geogrid/geotextile should be provided below the base of the cover blanket.).

Migration to Utilities

7.16 Any migration to utilities is unlikely to be significant. However, the local water company are likely to require details of the contaminants present on the site, to make a judgment on any requirement for protection of buried water supply pipes from chemical attack/ingress.

Risks During Construction Period

7.17 It is also necessary to consider the effects of the contamination present on the site in relation to the risks to adjacent residents, construction workers and the general public during construction. This is assessed in the following matrix.

Source	Pathway	Potential risk	Risk after employing suitable Health and Safety plan.
Existing made ground	Inhalation	Moderate	Damping down of the site during dry periods and timely placement of the existing made ground below barriers should block this pathway and reduce the risk to negligible.
Existing made ground	Ingestion	Moderate	Site fencing will exclude access to members of the public. Existing made ground will be contained within the site boundary and placed below barriers as soon as possible. Washing facilities and a clean mess room should be provided. These measures should block this pathway and reduce the risk to negligible.

Existing made ground	Contact	Moderate	Education of workers to use adequate hygiene and PPE should block this pathway and reduce the risk to negligible.
Existing made ground	Surface water	Moderate	Preventing surface water run off by minimising open exposure times of the existing made ground, and using bunds or cut off trenches as necessary should block this pathway and reduce the risk to negligible.

7.18 Provision of all the above measures will ensure that all the identified pathways for the contamination will be blocked.

Summary of Contamination Assessment and Remedial Options

7.19 The conceptual model has identified risks from the made ground materials from contamination by arsenic, copper, and lead, at maximum concentrations of 91mg/kg, 8,200mg/kg and 990mg/kg respectively, and also PAH, including benzo(a)pyrene recorded at 15mg/kg in two samples. In addition, chrysotile asbestos fibres were detected in demolition rubble and also in the ash and clinker made ground. Leachability is negligible.

7.20 The contamination risk assessment, and assessment of remedial options, has indicated that, provided that the following remedial measures are adopted then the risks to the identified receptors are deemed acceptable for the proposed development of residential properties with private gardens.

7.21 Where any garden or landscape areas overlie the existing made ground, a minimum 0.6m thickness of uncontaminated soils (topsoil and subsoil) should be provided. As chrysotile fibres have been identified, it is recommended that the cover blanket be underlain by a minimum 100mm thick hard break layer of coarse stone. In areas of hardstanding or building footprints, the cover blanket is not required.

7.22 It is understood that, in order to protect the culvert that underlies the western flank of the site, it is proposed to install a protective barrier in back gardens in this area. Any existing made ground below this barrier will be effectively encapsulated and, therefore, the hard break layer

could be omitted, and only 0.6m thickness of clean cover blanket placed, provided none of the original made ground is above the barrier. However, this will need to be agreed with the regulators.

7.23 Any imported soils used within the cover blanket will need to be verified as suitable by inspection and testing, in accordance with guidance supplied in the document produced by the Yorkshire and Lincolnshire Pollution Advisory Group (YALPAG): "Guidance on the Verification Requirements for Cover Systems".

7.24 The local water company are likely to require details of the contaminants present on the site, to make a judgment on any requirement for protection of buried water supply pipes from chemical attack/ingress.

7.25 A Contamination Remediation Statement is included in Appendix G.

8.0 GEOTECHNICAL TESTING

8.1 During the 2015 investigation, selected samples of the natural strata were delivered to PSL in Doncaster for testing with regard to plasticity indices and moisture content. Test certificates are presented in Appendix F and a summary of the results, including Modified Plasticity Indices, is given below.

Location	Depth (m)	MC	LL	PL	PI	<425µm	I'p
TP5	0.6	31	72	29	43	100	43
TP6	0.9	22	40	22	18	100	18
TP9	2.0	30	41	22	19	100	19
	No. of results	3	3	3	3		3
	Min.	22	40	22	18	100	18
	Max.	31	72	29	43	100	43

I'p	VCP
>40%	High
20% - <40%	Medium
10% - <20%	Low

MC = Moisture Content (%)	LL = Liquid Limit (%)	PL = Plastic Limit (%)
PI = Plasticity Index (%)	I'p = Modified PI (%)	VCP = NHBC Standard Chapter 4.2 Volume Change Potential

8.2 The plasticity test data shows clays of low to high plasticity, in accordance with BS 5930:2015 +A1:2020 "Code of Practice for Site Investigations". When the percentage retained on the 425-micron BS sieve is considered, the Modified Plasticity Index, in accordance with NHBC Standard Chapter 4.2 "Building Near Trees" is a maximum of 43. In accordance with the Standard, this equates to high Volume Change Potential.

8.3 Geochemical testing (water soluble sulphate and pH) was undertaken as part of the 2015 investigation, on selected samples by DETS, comprising nine samples of natural strata and eleven samples of made ground. In accordance with the BRE Special Digest 1 "Concrete in aggressive ground", the characteristic values for the two materials are given below:

Characteristic Values

Material	pH	SO_4
Made Ground	8	2,300
Natural Strata	7.8	775

SO_4 = Sulphate content in mg/l on a 2:1 water: soil extract pH = Acidity

8.4 The geochemical analyses show the natural strata to have a medium water-soluble sulphate content and near neutral pH. The Aggressive Chemical Environment for Concrete (ACEC) class is AC-2. However, testing on the made ground indicates class AC-3. Therefore, the use of FND3 designated concrete will be necessary for unreinforced buried concrete, in accordance with BS 8500-1:2015+A2:2019, if the existing made ground is to be retained. If the existing made ground was to be removed, the use of FND2 designated concrete would be satisfactory for unreinforced buried concrete. For any reinforced buried concrete, other design-specific mixes will apply.

9.0 GEOTECHNICAL ASSESSMENT

Coal Mining and Coal Recovery

9.1 The Coal Mining Report, within the Faber Maunsell Desk Study, indicates the site is stable with regard to coal mining and there are no recorded mine entries on or within 20m of the site.

Foundations

9.2 The made ground and underlying soft clay on the site is not considered suitable for support of foundation loads. In the eastern and central portion of the site (WS3, TP4, TP5, TP10 and TP12), the natural firm clay and granular soils are considered suitable, for the use of strip/trench fill foundations. An allowable bearing pressure of 80kN/m^2 is considered applicable.

9.3 As the made ground is greater than 2.5m deep in the south and northwest, standard strip or trench fill foundations will not be possible without a significant reduced dig. In addition, it will need to be ensured that foundations do not exert loading onto the culvert below the western flank. Therefore, pier/pad and beam foundations are considered likely to be the most favourable foundation solution in these locations, with the pads/piers founded onto the sandstone bedrock at around 3.0m to 3.5m depth. Alternatively, following removal of relic underground structures, it may be possible to re-engineer the made ground in the south of the site and use raft foundations. The use of piled foundations is also an option, although pre-drilling would probably be required to ensure minimum 3m pile lengths and to penetrate obstructions. Piles, if used, will need to be designed by a specialist piling contractor.

9.4 The chosen foundation solution should take into consideration the presence of buried concrete slabs at depth at TP1 (at 3.35m) and TP8 at 1.6m depth.

9.5 The clays were shown to be of high volume change potential. Therefore, in accordance with NHBC Standard Chapter 4.2 "Building Near trees", in the absence of trees, a minimum foundation depth of 1.0m below existing or proposed ground level is applicable, whichever is

the lower. However, in the presence of any proposed, existing or removed trees, the foundation may need to be deepened, depending on the type of tree and its distance from the face of the foundation. If not already available, a tree survey may be required to enable a foundation schedule to be prepared. The tree survey will also need to consider trees on third party properties.

9.6 The foundation should be taken below the depth of any existing foundations or obstructions, onto natural ground. The whole plan area of the foundation should be placed on similar natural material. Foundations should be reinforced where it is necessary to transition from suitable granular to suitable cohesive strata within a proposed building footprint.

Excavations

9.7 It is likely that excavations into the natural strata will remain stable in the short term, requiring minimal trench support, in accordance with the prevailing statutory guidance. However, instability may be anticipated within the made ground and within the natural sands below the water table.

9.8 During the 2015 investigation, groundwater seepage was only observed in TP11 at 3.00m. No groundwater was observed during the 2023 investigation. Any such encounters should be controllable by pumping from an artificial sump.

9.9 Excavations should be readily achieved using conventional hydraulic plant. However, excavations into intact bedrock or any buried foundations and structures are likely to require a hydraulic breaker. A breaker will be required to break out extensive areas of concrete at the surface as well as buried concrete that has been identified across the site.

Chemical Precautions

9.10 The Aggressive Chemical Environment for Concrete (ACEC) class is AC-2 for the natural strata and AC-3 for the made ground. Therefore, the use of FND3 designated concrete will be required for unreinforced buried concrete, in accordance with BS 8500-1:2015+A2:2019. For any reinforced buried concrete, other design-specific mixes will apply.

Road Pavement Construction

9.11 Due to the depth of existing made ground on the site, a formation for adoptable road pavement on natural strata is likely to be impractical. It may be possible to reach agreement with the Local Regulatory Authority to remove a nominal thickness of made ground, for example 1m, proof roll, and place engineered material to a controlled specification.

Flooding and Soakaways

9.12 The site is within an area at risk from river flooding. It would be prudent to consult with the Environment Agency with regard to proposed finished floor levels on the site, and a specialist flood risk assessment report may be required, if not already available.

9.13 BGS data indicates the general area has the "limited potential for groundwater flooding to occur".

9.14 If the disposal of surface water using soakaways was to be used on the site, there would be minimal attenuation, as the water would probably enter the River Calder quickly, either through groundwater flow or via the culvert. Therefore, the use of soakaways is likely to be of minimal benefit.

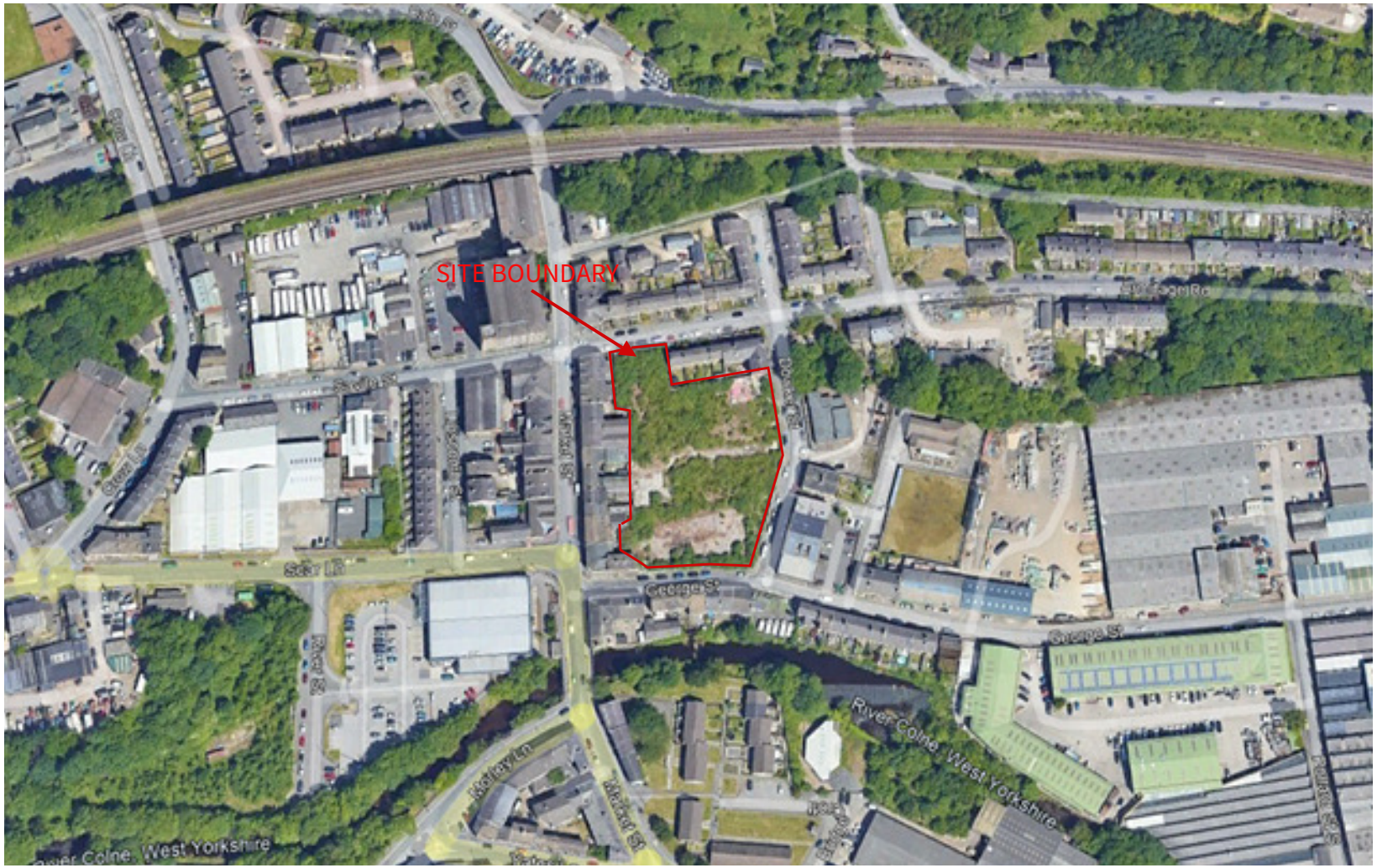
Gas Protection

9.15 No radon protective measures are required for properties constructed on the site.

9.16 There are no landfills within 250m of the site, and no shallow coal seams/coal workings affecting the site. Therefore, there should be no requirement for gas protection within the proposed properties.

A P P E N D I X A

SITE LOCATION PLAN, AERIAL PHOTOGRAPH AND PROPOSED LAYOUT



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Project
DOWKER STREET, MILNSBRIDGE

Client
WESTSHIELD LIMITED

Title
AERIAL PHOTOGRAPH 2022

Date
JUNE 2023

Drawn	Scale
OG	AS SHOWN

Job No.
WSD/01

Proposed Site Plan

1 : 500

Area Schedule

Type	Description	Area
BTP - Adopted Footpath	Light Grey	326 m²
BTP - Adopted Road	Dark Grey	484 m²
BTP - Car Parking	Salmon	544 m²
BTP - Front Garden	Dark Green	74 m²
BTP - Plot Hardstanding	Light Grey	623 m²
BTP - POS Zone	Dark Green	855 m²
BTP - Private Garden	Light Green	540 m²
BTP - Unadopted Drive	Brown	291 m²
Total: 76		3738 m²

Fence Schedule

Type	Fence Height	Length
Fence - TSW 1800mm Trellis	1.800	131.8
Fence - TSW 2100mm	2.100	61.7
Total: 15		193.5

KEY

8m distance from culvert

Culvert

Schedule of Accommodation

14no 1B2P Flats @ 50m²
8no 2B3P Flats @ 61m²
2no 1B2P Flats @ 61m²
06no 2B3P House (Semi-Detached) @ 70m²
02no 2B4P House (Semi-Detached) @ 79m²
04no 3B4P House (Semi-Detached) @ 84m²
02no 3B5P House (Semi-Detached) @ 92m²
38no Total

1B2P Cottage Flat - 100% parking spaces
2B4P House - 100% parking spaces
3B5P House - 200% parking spaces

Caveats
- Overlooking distances subject to LPA Approval
- Density and parking mix subject to LPA Approval

Layout subject to confirmation of red line boundary, all statutory approvals including highways, planning and building regulations, relevant surveys and reports such as topographical, ecology, trees, ground investigation and flood risk.

DO NOT SCALE FROM THIS DRAWING
ALL DIMENSIONS MUST BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION

Rev	Date	Int	Description
12	17.08.22	ED	Red line boundary added.
11	03.08.22	ED	Drawing revised folloiwing meeting with contractor
10	01.08.22	ED	Drawing revised following receipt of updated culvert drawing
9	26.07.22	ED	Drawing revised following location of culvert
8	23.06.22	ED	Drawing revised following receipt of topographical survey
7	09.06.22	ED	Drawing revised following client meeting
6	30.05.22	JW	Plot 1-9 updated to show mix of 1B2P and 1B1P. Schedule of accommodation updated
5	Date 5	JW	Plot 1-4 (3B4P and 2B3P) swapped out for Plot 1-9 (1B2P)
4	06.05.22	JW	Drawing updated to show 37 houses as per clients request
3	05.05.22	JW	Drawing updated to show culvert. Housing layout rearranged following addition of culvert
2	17.01.22	AP	Drawing revised following comments from Client - Flat Block replaced by Cottage Flats
1	13.01.22	ED	Drawing revised following comments from Client

btp ARCHITECTS
RIBA Chartered Practice

CLIENT:
SEP Construction

PROJECT:
Dowker Street, Milnsbridge

DESCRIPTION:
Proposed Site Plan - Option 2

PURPOSE OF ISSUE:
Feasibility

DRAWN BY:	CHECKED BY:	DATE:	SCALE @ A3:
ED	VJS	09.12.21	As indicated

JOB NO:	STATUS CODE:	DRAWING NO:	REV:
4016	S0	106	12

FILE IDENTIFIER:
DS-BTP-00-SP-DR-A-4016_106.12

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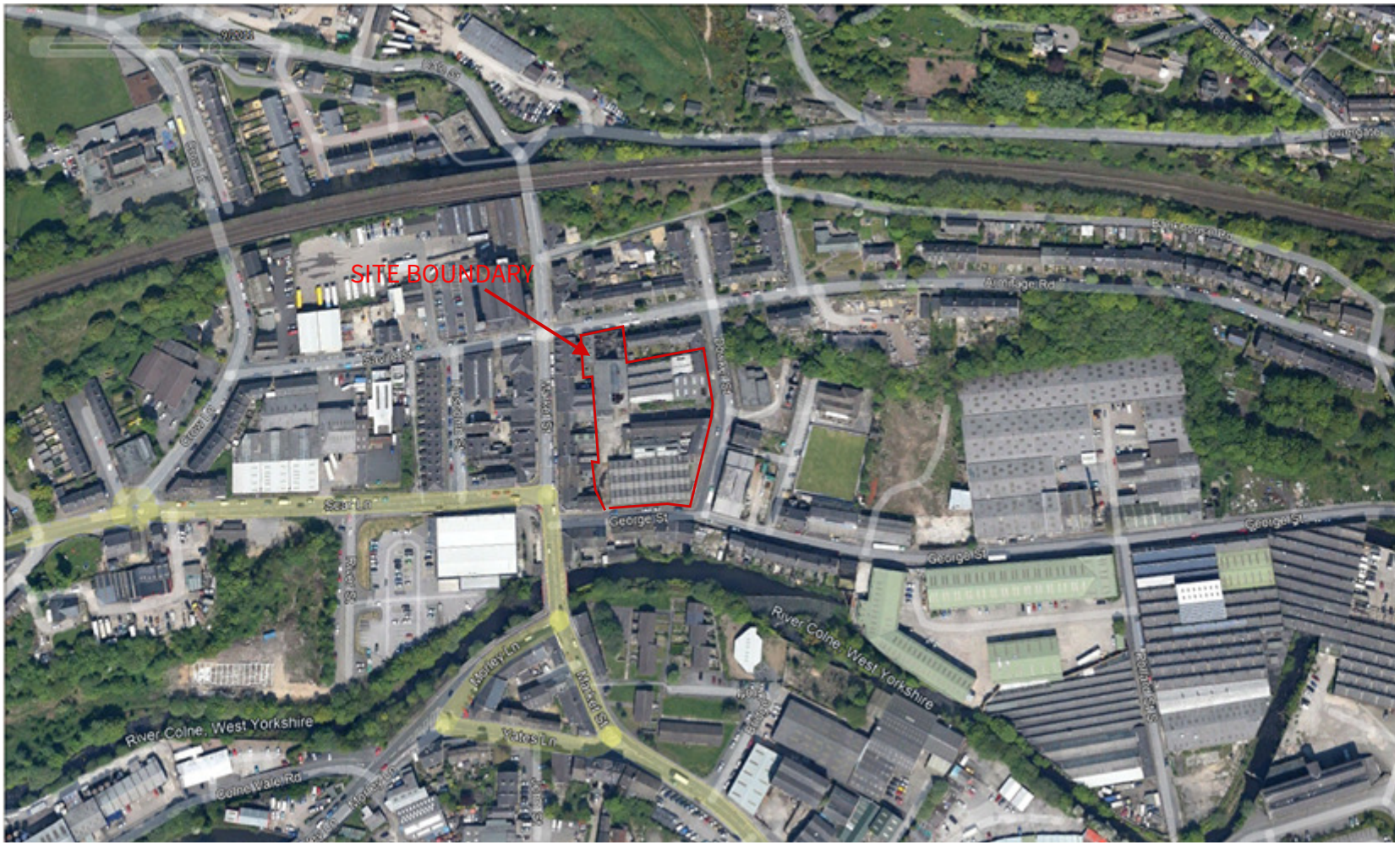

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Project
DOWKER STREET, MILNSBRIDGE

Client
WESTSHIELD LIMITED

Title
AERIAL PHOTOGRAPH 2011

Date
JUNE 2023

Drawn	Scale
OG	AS SHOWN

Job No.
WSD/01

APPENDIX B

SITE WALKOVER PHOTOGRAPHS

Photograph 1: Boarding along former access off Dowker Street along the eastern boundary of the site.

Photograph 2: Eastern boundary of the site along Dowker Street, facing south towards George Street.

Photograph 3: Southeastern end of the site, facing south.

Photograph 4: Vegetation towards the centre of the site, facing west.